Human 6G Antennas? 'One of the Worst Ideas Ever,' Critic Says

By Dr. Suzanne Burdick
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Human beings could be used as part of an electromagnetic radiation (EMR) antenna system by wearing a special copper-coiled bracelet, according to a team of researchers at the University of Massachusetts Amherst and Delft University of Technology in The Netherlands.

The researchers said they developed a low-cost way to "harvest" the radiofrequency (RF) radiation that gets "leaked" during visible light communication (VLC) — a technology they said is likely to be used in the "coming 6G networks."

But some critics allege that using human beings as RF antennas for 6G is disrespectful to the human body and may have unknown health implications.

> "I am diametrically opposed to this type of work, especially given the paucity of medical research on using the human body as an RF antenna," said Brian Hooker, Ph.D., P.E., Children's Health Defense (CHD) chief scientific officer and professor of biology at Simpson University.
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> "This type of technology makes the human body an RF collector and ignores the health implications of EMR altogether," Hooker told The Defender.

'LiFi' can 'enable new pervasive wireless systems' for Internet of Things

The researchers — including Jie Xiong, Ph.D., an associate professor of information and computer sciences at the University of Massachusetts Amherst and Qing Wang, Ph.D., an assistant professor in the Embedded Systems Group in the Department of Software Technology at TU Delft, The Netherlands — are proponents of VLC, or "LiFi" as it is sometimes called, which uses light to transmit data.

VLC works by turning LED lights on and off at a very high speed invisible to the human eye.

Like WiFi, VLC is wireless — but instead of using a router and RF waves to transmit data, VLC uses LED bulbs and light signals to send and receive information.

According to OpenVLC, a research platform co-founded by Wang, VCL can "enable new pervasive wireless systems in the context of the Internet of Things."

During VLC, RF radiation is "leaked" into the ambient environment, allowing it to be "harvested" and used to power small devices, the researchers said.

The team designed an electrical system called "Bracelet+" whereby a human wearing a bracelet containing a copper coil could "collect" the RF radiation generated during VLC.

The researchers said they were able to harvest microwatts of power using their copper-coiled bracelet system in tested scenarios.

"Such a micro-watt level of harvested energy has the potential to power up ultra-low-power sensors such as temperature sensors and glucose sensors," they said.

The team did not specify in their design how the harvested radiation would be relayed to devices.

Two bracelets harvest more RF than one

The team said they were able to harvest more RF radiation when an individual wore two bracelets, one on each arm.

Increasing the number of bracelets would not increase the wearer's exposure to RF, according to Minhao Cui — a Ph.D. student of information and computer sciences at the University of Massachusetts Amherst who worked with Xiong on the project.

"The Bracelet only 'extracts' [RF] energy from the human body, which is already captured by the human body," he said, "so no matter how many bracelets we wear, [it] will not influence people's exposure to RF."

The team said wearing the bracelet "does not cause any health issues" because the maximum amount of RF radiation from VLC is "around 0.01 microwatts per squared centimeter ($mW/cm^{2)"}$ — which is "far below" the RF limits specified by the Federal Communications Commission (FCC) and the U.S. Food and Drug Administration (FDA).

FCC guidelines set the limit for human exposure to RF at 0.2 mW/cm^2 and FDA specifies an upper limit of 10 mW/cm^2, they said.

'One of the worst ideas ever'

However, Bill Bathgate, an electrical engineer and certified building biology environmental consultant, said it wasn't feasible to think that wearing the bracelets would not increase people's exposure to RF. "That's not possible," he said.

Commenting on the study, Bathgate said, "This is one of the worst ideas ever." It uses the human body as a "telecommunications point in some kind of network grid" and could result in "health effects we can't predict," he said.

Bathgate criticized the researchers for using FCC and FDA regulations as a measure of health impacts. “These are the two of the most corrupt organizations I’ve ever met in this field of electrical engineering,” he said.

“The FCC is not a health agency,” Bathgate said, “The FDA is — but it doesn’t know anything about RF.”

Bathgate pointed out that in 2021, CHD sued the FCC successfully for being unable to explain why its current guidelines adequately protect against the harmful effects of exposure to RF radiation.

The U.S. Court of Appeals ruled the FCC failed to consider the non-cancer evidence regarding adverse health effects of wireless technology in its decision to not update its 1996 guidelines.

Bathgate said he would have liked to see the study authors provide evidence to support their claim that the leaked RF radiation from VLC does not cause health issues. “What measurements have been done to validate that statement?” he asked.

“You have to be careful … people throw this stuff out there without even thinking about the potential ramifications of it,” he said, adding that prior research has indicated clear interactions between EMR exposure — including RF — and health problems.

Thousands of peer-reviewed studies have shown non-thermal biological effects — meaning effects from low-level radiation that does not cause heat — at the cellular level including oxidative stress, DNA damage, sperm damage, neurological effects, cognitive impairment and electrosensitivity.

Nonetheless, Cui said he didn’t think VLC has an impact on people’s health. “The energy of leaked RF signals from the VLC is largely below that of Wi-Fi signals already in the environment,” he added.

‘Making the human body the ground plane for 6G communications’

Bathgate broke down the science behind why the study authors would want to use the human body to collect the RF generated by VLC.

In VLC, when LED bulbs oscillate at a very high frequency it allows signals to be sent at very low power. These signals get transferred to the human body, Bathgate said, making the body an “amplifying antenna” for the signals.

“Basically, what we’re talking about here is making the human body the ground plane for 6G communications,” he added.

“If you drive by a TV tower or radio tower, you see this big thing going up in the air. Underneath that tower — which you can’t see — is a very large copper sheet the size of a parking lot.”

That’s the ground plane for the antenna, he said. “The antenna on its own will not radiate unless it has a counterpoise — or a ground plane — to reflect the information from.”

Bathgate said that human beings are very effective as being a ground plane because they

are “saltwater beings.”

For example, he said, if he wanted to get a really strong signal using a ham radio, he would go to a saltwater beach and “literally stick” the antenna in the sand where the saltwater is.

The saltwater would amplify the signals “very quickly and very effectively,” he said, by making the ocean — “half the earth” — the ground plane. “It will make my antenna a lot more effective than if I were to be a hundred yards inland,” he said.

Indeed, the study authors tested various objects to ascertain which ones functioned most effectively to amplify the RF radiation produced during VLC and found that the human body was the best “object” for collecting the RF radiation.

They first put a copper coil on objects — made of plastic, cardboard, wood and steel — but found metal to be the most effective. Then, they tested objects “ubiquitous” in daily life including walls, electronic devices (such as a smartphone and laptop) and the human body.

They concluded that the human body — with its many watery tissues — was more effective at amplifying the harvestable RF radiation than electronic devices or walls.

The study authors did not discuss what amount of RF radiation might be expected to occur in individuals exposed to VLC who wear copper jewelry similar to their copper-coiled bracelet or in women who use a copper intrauterine device as a form of long-term birth control.

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